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Synthesis of New Disperse Dyes Based on Enaminones Derivatives: Part 2. Antioxidant Activities

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Abstract
After we prepared a series of new disperse dyes in our previous study, and to complement our strategy towards studying the use of what we are synthesizing and using it as antioxidants, the results showed that these disperse dyes can be used as antioxidants materials.
Keywords*: disperse dyes, *antioxidant activities

1. Introduction

Disperse dyes have been used increasingly commonly in industrial textiles since the invention of synthetic fibres. On almost all synthetic materials, applying disperse colours is relatively simple when utilising simple exhaustion techniques [1-19]. The use of antioxidants in the medical sciences has drawn more attention in recent years. Free radicals can oxidize lipids, proteins, and DNA and start a degenerative illness, including inflammatory, arthritic, and cancer diseases of the cardiovascular and nervous systems. Owing In light of these facts, synthetic substances that could increasing attention is being paid to antioxidant activity in research in biology and medicine [15]. The textile industry would use more dyes. The objective of the project was to use these disperse dyes as potential antioxidants.

2. Materials and Methods

General Procedure for the Synthesis of Disperse Dyes 5a-f

The disperse dyes were prepared according to the method that we published in our previous study [2].

Dyeing procedure

The dye bath (liquor ration 1:30) contained (1.5%) of levegal MDL as dispersing agent and (3% of) TANAVOL EP 2007 as anionic eco-friendly carrier in case of dyeing at 100 °C or just use dispersing agent in case of dyeing at 130 °C. The dye bath's pH was raised to 5.5 using aqueous acetic acid before the addition of the wetted-out polyester textiles (3 gramme). We carried out dyeing by gradually increasing the dye bath's temperature to 100 or 130°C and maintaining it there for 60 minutes. The coloured fibres were reduced (1 g/L sodium hydroxide, 1 g/L sodium hydrosulfite, 10 min, 80°C) and cleared after being cooled to 50°C. The samples were cleaned in both hot and cold water before being dried by air.

DPPH Radical Scavenging Activity:

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical was freshly produced in methanol solution (0.004%w/v) and kept at 10C in the dark. It was created a methanol solution of the test substance. The DPPH solution was mixed with a 40 uL aliquot of the methanol solution. A UV-visible spectrophotometer (Milton Roy, Spectronic 1201) was used to take instantaneous absorbance values. Until the absorbance stabilised (16 minutes), the decline in absorbance at 515 nm was monitored constantly, with data being recorded at 1 minute intervals. Ascorbic acid was used as a reference chemical, and both its absorbance and that of the DPPH radical without an antioxidant were also assessed. Three replicates of each determination were made, and the average was calculated. The formula was used to compute the DPPH radical's percentage inhibition (PI).

$$PI = [\{(AC- AT)/ AC\} \times 100] \quad (1)$$

Where AC = Absorbance of the control at t = 0 min and AT = absorbance of the sample+DPPH at t = 16 min**.** The 50% inhibitory concentration (IC_{50}), the concentration required to inhibit DPPH radical by 50%, was estimated from graphic plots of the dose response curve

Color Measurements

The colorimetric parameters of the dyed polyester fabrics were determined on a reflectance spectrophotometer. The color yields of the dyed samples were determined by using the light reflectance technique performed on an UltraScan PRO D65 UV/VIS Spectrophotometer. The

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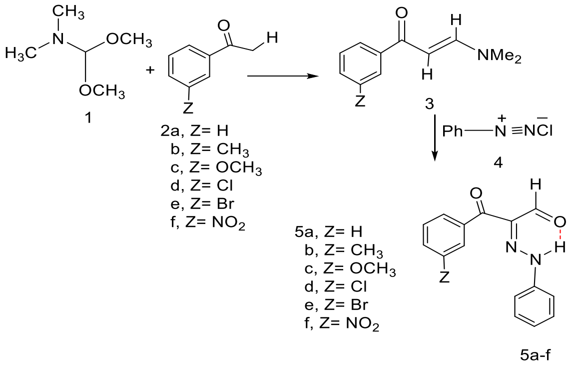
color strengths, expressed as K/S values, were determined by applying the Kubelka-Mink equation.

$$K/S = \frac{(1-R)^2}{2R} - \frac{(1-R^0)^2}{2R^0}$$

Where, R is the reflectance of colored samples and K and S are the absorption and scattering coefficients, respectively.

3. Result and discussion

In this study, polyester fabrics were initially dyed at high temperatures utilizing these novel disperse dyes based on enaminones. (scheme 1). The antioxidant activity of the disperse dyes was assessed in vitro (DPPH), along with their capacity to scavenge free radicals. The IC_{50} value of the dyes, the dose needed to suppress the production of DPPH radicals by 50%, was used to describe their antioxidant activity (See Tables 1-7). According to the data in Table (8), disperse dyes **5b** has poor antioxidant activity (IC_{50} values of 143.34) (Figure 2). when compared to ascorbic acid, which has a substantial antioxidant activity (IC_{50} value of 10.62; (see Figure 7). Quite the opposite, dye **5a** displays excellent antioxidant activity, with an (IC_{50} of 14.94) when compared to ascorbic acid, which has a substantial antioxidant activity (IC_{50} value of 10.62; see Figure 1).



Scheme 1: Structures of new disperse dyes

Table 1: Antioxidant Activity of disperse dye **5a**

Sample conc. (μg/ml)	DPPH scavenging %	S.D. (±)
1000	91.89	0.23
500	89.40	0.24
250	82.76	0.68
125	76.04	0.71
62.5	70.83	0.95
31.25	62.95	0.73
15.6	51.48	0.86
7.8	33.87	0.95
3.9	24.19	0.73
2	15.68	0.84
0	0	0

Table 2: Antioxidant Activity of disperse dye **5b**

Sample conc. (μg/ml)	DPPH scavenging %	S.D. (±)
1000	78.97	0.19
500	71.56	0.82
250	56.34	1.68
125	48.91	1.73
62.5	37.15	1.97
31.25	24.92	0.64
15.6	11.87	0.35
7.8	6.34	0.12
3.9	2.95	0.33
2	0.89	0.17
0	0	0

Table 3: Antioxidant Activity of disperse dye **5c**

Sample conc. (μg/ml)	DPPH scavenging %	S.D. (±)
1000	88.14	0.28
500	82.37	0.51
250	75.18	0.65
125	68.90	0.34
62.5	59.43	0.69
31.25	51.70	2.04
15.6	31.78	1.86
7.8	22.09	0.63
3.9	8.27	0.51
2	3.85	0.23
0	0	0

Table 4: Antioxidant Activity of disperse dye **5d**

Sample conc. (μg/ml)	DPPH scavenging %	S.D. (±)
1000	85.86	0.18
500	80.95	0.21
250	71.42	0.36
125	63.78	0.46
62.5	54.21	0.38
31.25	46.39	0.67
15.6	29.41	0.73
7.8	19.73	0.65
3.9	7.46	0.19
2	2.98	0.28
0	0	0

Table 5: Antioxidant Activity of disperse dye **5e**

Sample conc. (μg/ml)	DPPH scavenging %	S.D. (±)
1000	82.31	0.73
500	75.29	1.45
250	65.06	1.92
125	56.17	0.91
62.5	47.59	0.63
31.25	32.81	0.74
15.6	18.74	0.62
7.8	9.52	0.44

3.9	4.13	0.21
2	1.75	0.43
0	0	0

Table 6: Antioxidant Activity of disperse dye **5f**

Sample conc. (µg/ml)	**DPPH scavenging %**	**S.D. (±)**
1000	81.74	0.28
500	74.93	0.45
250	64.27	0.96
125	53.85	1.81
62.5	44.32	1.74
31.25	29.74	0.92
15.6	17.20	0.84
7.8	8.64	0.12
3.9	3.75	0.33
2	1.29	0.17
0	0	0

Table 7: Evaluation of Antioxidant Activity using DPPH scavenging for ascorbic acid

Sample conc. (µg)	**DPPH scavenging %**	**S.D.**
1280	98.91	0.74
640	97.83	0.39
320	95.64	1.22
160	92.31	0.87
80	90.25	0.41
40	83.09	1.95
20	71.38	1.39
10	48.52	2.64
5	40.36	0.82
2.5	34.57	0.79
0	0	

Table 8. Antioxidant activities of the dyes **5a-f**.

Dye No.	**Antioxidant activity (IC_{50} µg/ml)**
5a	14.94 ± 0.69
5b	143.34 ± 5.49
5c	29.87 ± 1.64
5d	2.13
5e	80.06 ± 3.86
5f	99.75 ± 4.17
Ascorbic acid	10.62 ± 0.84

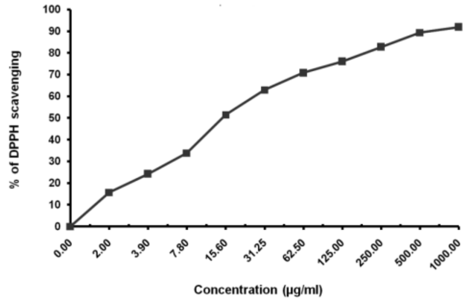


Figure 1: Antioxidant Activity for disperse dye **5a**

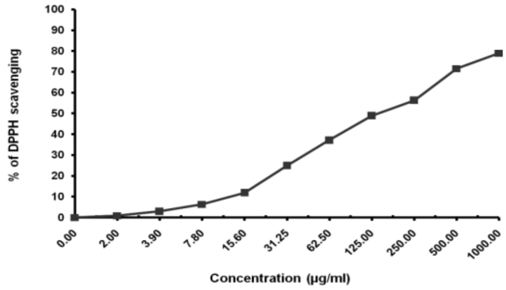


Figure 2: Antioxidant Activity for disperse dye **5b**

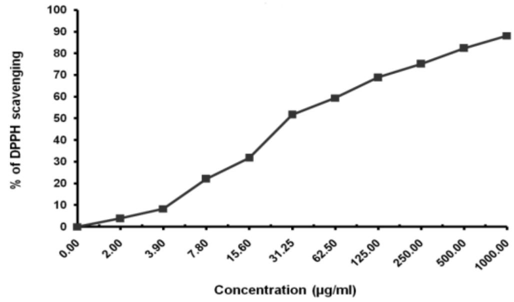


Figure 3: Antioxidant Activity for disperse dye **5c**

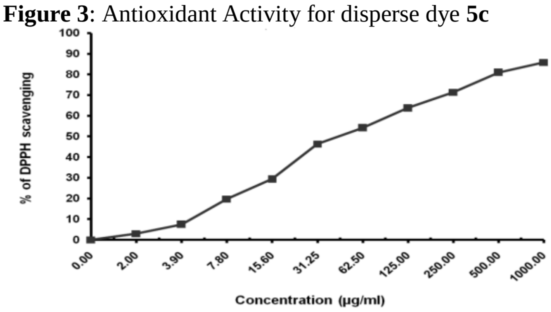


Figure 4: Antioxidant Activity for disperse dye **5d**

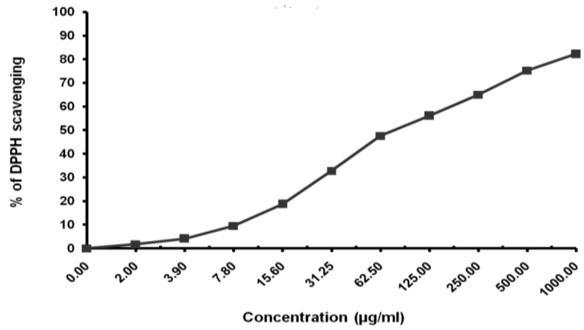


Figure 5: Antioxidant Activity for disperse dye **5e**

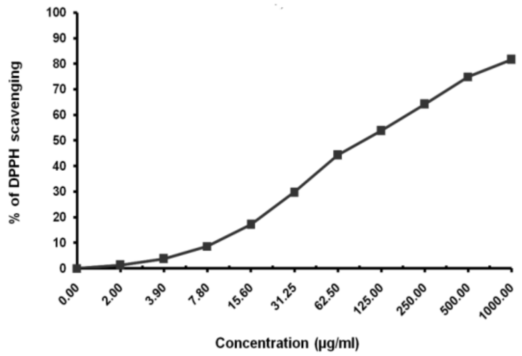


Figure 6: Antioxidant Activity for disperse dye **5f**

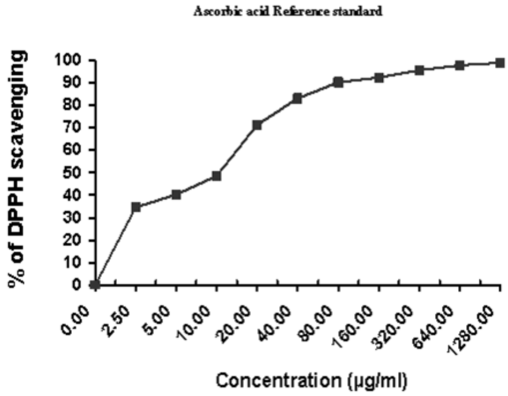


Figure 7: Antioxidant Activity for ascorbic acid refernce standard

Disperse dyes **5e** and **5f** have good antioxidant activity (IC_{50} values of 80.06 and 99.75, respectively) when compared to ascorbic acid, which has a substantial antioxidant activity (IC_{50} value of 10.62; see Figure s 5 and 6). Disperse dye **5c** has a very good antioxidant activity, with an (IC_{50} of 29.87) when compared to ascorbic acid, which has a substantial antioxidant activity (IC_{50} value of 10.62; see Figure 3). Finally, dye **5d** displays higher than excellent antioxidant activity, with an (IC_{50} of 2.13), when compared to ascorbic acid, which has a substantial antioxidant activity (IC_{50} value of 10.62; see Figure 4).

Conclusions

In this study, we showed that the prepared disperse dyes have an important activities and these disperse dyes can be used as antioxidants materials.

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